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July 7, 2014

Via Electronic Filing

Ms. Barcy McNeal
Administration/Docketing
Public Utilities Commission of Ohio
180 East Broad Street, 11th Floor
Columbus, OH 43215-3793

Re: Hardin Wind Energy LLC
OPSB Case No. 14-1030-EL-BGA

Dear Ms. McNeal:

As referenced in Section 4906-17-08(A)(6), pages 23-24, of Hardin Wind Energy LLC's Application filed on June 5, 2014, attached is a copy of the shadow flicker study.

Please do not hesitate to contact me if you have any questions.

Sincerely,

Sally W. Bloomfield

Attachment

Cc: Don Rostofer (w/Attachment)
Parties of Record (w/Attachment)

Shadow Flicker Impact Analysis for the Hardin Wind Farm

Prepared for

Hardin Wind Energy LLC

Prepared by

TETRA TECH

160 Federal Street
Boston, MA 02110

July 2009
Updated December 2009
Updated June 2011
Updated June 2014

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ATTACHMENT

Attachment A Detailed Summary of WindPro Shadow Flicker Analysis Results

EXECUTIVE SUMMARY

A shadow flicker impact analysis was originally conducted for the Hardin Wind Farm Project (Project) in July 2009. That analysis was based on the original 212 wind turbine layout project design. The July 2009 analysis was updated in December of 2009 to evaluate the revised Project based on a layout design comprising 203 wind turbines. The analysis was again updated to evaluate the Phase 1a project layout of 132 wind turbines in June of 2011. This analysis has been further updated to evaluate the revised project layout of 121 wind turbines and a new wind turbine model (GE 2.5 – 120) as of June of 2014.

The calculated sunshine probability data is presented in Section 2. The WindPro prediction results are presented in Section 3.

1.0 BACKGROUND

A wind turbine's moving blades can cast a moving shadow on locations within a certain distance of a turbine. If the shadows pass over a window of a home or public gathering place, they can create alternating periods of low and high light, a temporary phenomena referred to as "shadow flicker". The maximum length of the shadows depends on the time of year and day (which determines the sun's azimuth and altitude angles) and the wind turbine's physical characteristics (height, rotor diameter, blade width, and orientation of the rotor blades). Shadows are longest during low angle sunlight conditions, typical during sunrise and sunset times of the day. However, when the sun angle gets very low (less than 3 degrees), the light has to pass through more atmosphere and becomes too diffuse to form a coherent shadow. Shadow flicker will not occur when the sun is obscured by clouds or fog, at night, or when the source turbine(s) are not operating.

Shadow flicker intensity is defined as the difference in brightness at a given location in the presence and absence of a shadow. Shadow flicker intensity diminishes with greater receptor-to-turbine separation distance. Shadow flicker intensity for receptor-to-turbine distances beyond 1,500 meters is very low and generally considered imperceptible. Shadow flicker intensity for receptor-to-turbine distances between 1,000 and 1,500 meters (between 3,281 and 4,921 feet) is also low and generally considered barely noticeable. At this distance shadow flicker intensity would only tend to be noticed under conditions that would enhance the intensity difference, such as observing from a dark room with a single window directly facing the turbine casting the shadow. At distances less than 1,000 meters (3,281 feet), shadow flicker may be more noticeable. In general, the largest number of potential shadow hours, along with greatest potential shadow flicker intensity, occurs nearest the wind turbines.

Shadow flicker intensity is also affected by the relative percentage of the solar disk which is masked (covered) by the turbine rotor. WindPro calculations also implements German guidance which indicates that when less than 20% of the solar disk is masked, the shadow will be too diffuse to cause a significant impact.

Shadow flicker frequency is related to the wind turbine's rotor blade speed and the number of blades on the rotor. From a health standpoint, such low frequencies are harmless. For comparison, strobe lights used in discotheques have frequencies which range from about 3 Hertz (Hz) to 10 Hz (1 Hz = 1 flash per second). As a result, public concerns that flickering light from wind turbines can have negative health effects, such as triggering seizures in people with epilepsy are unfounded. The Epilepsy Action (working name for the British Epilepsy Foundation), states that there is no evidence that wind turbines can cause seizures. However, they recommend that wind turbine flicker frequency be limited to 3 Hz (http://www.epilepsy.org.uk/info/photo_other.html). Since the proposed Project's wind turbine blade pass frequency is approximately 0.65 Hz (less than 1 alternation per second), no negative health effects to individuals with photosensitive epilepsy are anticipated.

2.0 WINDPRO SHADOW FLICKER ANALYSIS

Tetra Tech estimated potential shadow flicker impacts from the Hardin Wind Farm using the WindPro software package and the following information provided by Hardin Wind Energy LLC (HWE):

- 121 turbines are located at the coordinates listed in Attachment B. HWE reports these coordinates match those used for the layout submitted to the OPSB in its amendment application dated June 5, 2014.
- The wind turbines are assumed to have the dimensions of the GE Wind Energy GE 2.5-120, a 3-blade 120-meter-diameter rotor wind turbine with a hub height of 85 meters. The GE 2.5-120 has a nominal rotor speed of 13.0 rpm which translates to a blade pass frequency of 0.65 Hz (less than 1 alternation per second).
- Receptors are located at the coordinates listed in Attachment A.

The analysis makes the following assumptions:

- The elevations of the wind turbines and receptors are determined using USGS digital elevation model (DEM) data.
- The position of the sun and the incident sunlight relative to the wind turbine and receptors on a minute by minute basis over the course of a year.
- Annual average sunshine rates for the area are based on an average of National Climatic Data Center (NCDC) data for stations located in Columbus and Toledo, Ohio and are assumed to be:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
38.5%	44%	47%	51.5%	58%	62%	62.5%	61.5%	61%	55%	37%	32%

  Values from Columbus and Toledo were used because NCDC sunshine data is not available for Kenton, Ohio[1], but it is available for measurement stations in both Columbus and Toledo, Ohio. The sunshine probability data from these stations were averaged together to calculate sunshine probability data assumed to be representative of the of the project area. Tetra Tech considers this to be a conservative assumption that underestimates cloud cover since it evenly averages data from both sites, even though the project is slightly closer to Columbus and Columbus has a higher cloud cover rate.

- Wind turbine operating hours and orientations are based on approximately 1 year of data measured on-site from 5/21/08 to 6/22/09. Based on this data, wind turbine orientations are assumed to be as follows:

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW
4.1%	5.6%	7.7%	6.6%	4.9%	6.3%	8.7%	15.1%	13.1%	13.1%	9.1%	5.8%

[1] Alan Black, NOAA Midwestern Regional Climate Center, data request response via email on 11/4/09.

- Receptor viewpoint (i.e., house windows) is assumed to always be directly facing turbine to sun line of sight ("greenhouse mode").

- Every receptors is modelled as a 1 m^2 area (approximate size of a typical window), 1 meter (3.28 feet) aboveground level. Approximate eye level is set at 1.5 meters (4.9 feet).

- Screening from trees, shrubs, barns, or other obstacles was conservatively not assumed to block shadows. In reality, such factors can block shadows from falling on to windows of receptors.

WindPro incorporates terrain elevation contour information and the analysis accounts for terrain elevation differences. WindPro calculates the sun's path with respect to each turbine location to determine the shadow paths for every minute in a full year. Sun angles less than 3 degrees above the horizon were excluded, for the reasons identified in Section 1. WindPro calculates shadow flicker for conditions when at least 20% of the sun disc is covered by the turbine blades. When less than 20% of the solar disk is masked by the blades, the shadow will be too diffuse to cause a coherent shadow

Tetra Tech identified 559 receptors within 1,000 meters of a proposed wind turbine. Only these receptors were analyzed in the WindPro analysis. Figure 1 shows the locations of the modelled receptors and turbines.

3.0 WINDPRO SHADOW FLICKER ANALYSIS RESULTS

Expected annual average shadows are provided in Attachment A for all modelled receptors. Table 1 presents the expected annual average shadow hours for the receptors expected to receive over 30 hours of shadows per year.

Table 2 summarizes the expected annual average shadow hours for all receptors modelled.

Table 1. Receptors with Over 30 Expected Annual Average Shadow Hours

Receptor ID	Expected Annual Average Shadow Hours [Hours: Minutes/Year]	Project Participation Status	Shadow Percent of Available Sunlight Hours
71570	50:54	Participant	1.14%
71494	47:10	Non-Participant	1.06%
71376	43:26	Non-Participant	0.97%
77227	43:07	Participant	0.97%
69963	43:04	Participant	0.97%
71308	42:45	Non-Participant	0.96%
71581	42:07	Participant	0.95%
71547	37:47	Non-Participant	0.85%
69866	37:16	Non-Participant	0.84%
71460	36:49	Participant	0.83%
69830	35:55	Non-Participant	0.81%
70361	35:48	Participant	0.80%
71441	34:39	Non-Participant	0.78%
77027	34:39	Non-Participant	0.78%
71131	33:26	Participant	0.75%
71012	33:05	Non-Participant	0.74%
71383	32:46	Non-Participant	0.74%
69812	32:38	Participant	0.73%
77228	32:22	Non-Participant	0.73%
71182	31:51	Non-Participant	0.71%
70142	31:47	Non-Participant	0.71%
82541	31:04	Non-Participant	0.70%
71346	30:55	Non-Participant	0.69%
71001	30:29	Participant	0.68%
71307	30:23	Non-Participant	0.68%
71027	30:09	Non-Participant	0.68%

Table 2. Statistical Summary of Expected Annual Average Shadow Hours

Annual Average Shadow Hours	Number of Non-Participating Receptors	Number of Participating Receptors	Number of Total Receptors
= 0 Hours	25	1	26
> 0 and < 10 Hours	297	29	326
≥ 10 and < 20 Hours	106	18	124
≥ 20 and < 30 Hours	47	10	57
> 30 hours	17	9	26
Total	492	67	559

4.0 CONCLUSION

Shadow flicker impacts within the area of study are expected to be minor. The analysis assumes that the houses all have a direct in line view of the incoming shadow flicker sunlight and does not account for all the trees or other obstructions which may block sunlight. In reality, the windows of many houses will not face the sun directly for the key shadow flicker impact times. For these reasons, shadow flicker impacts are expected to be less than estimated with this conservative analysis, and shadow flicker is not expected to be a significant environmental impact.

Figure 1 Map Describing Sensitive Receptors (Houses) Modeled with WindPro to Predict Potential Shadow Flicker Impacts

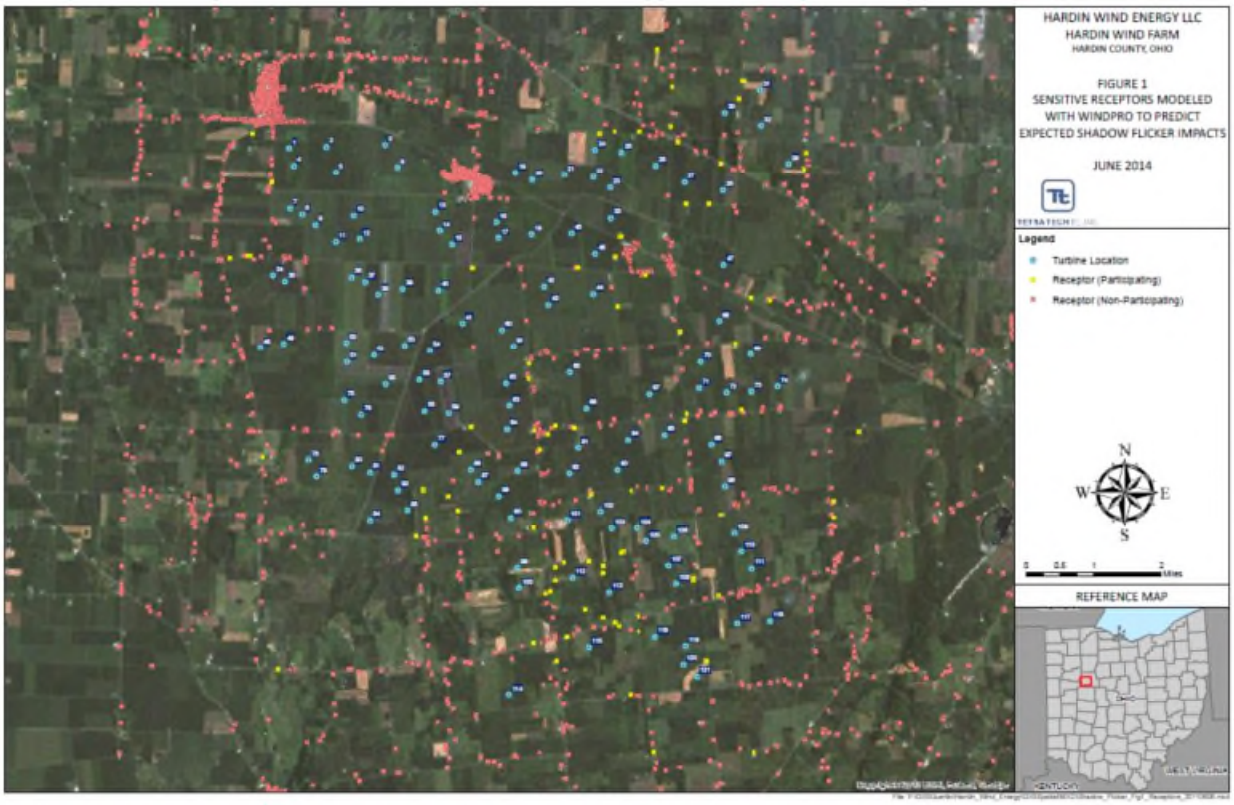
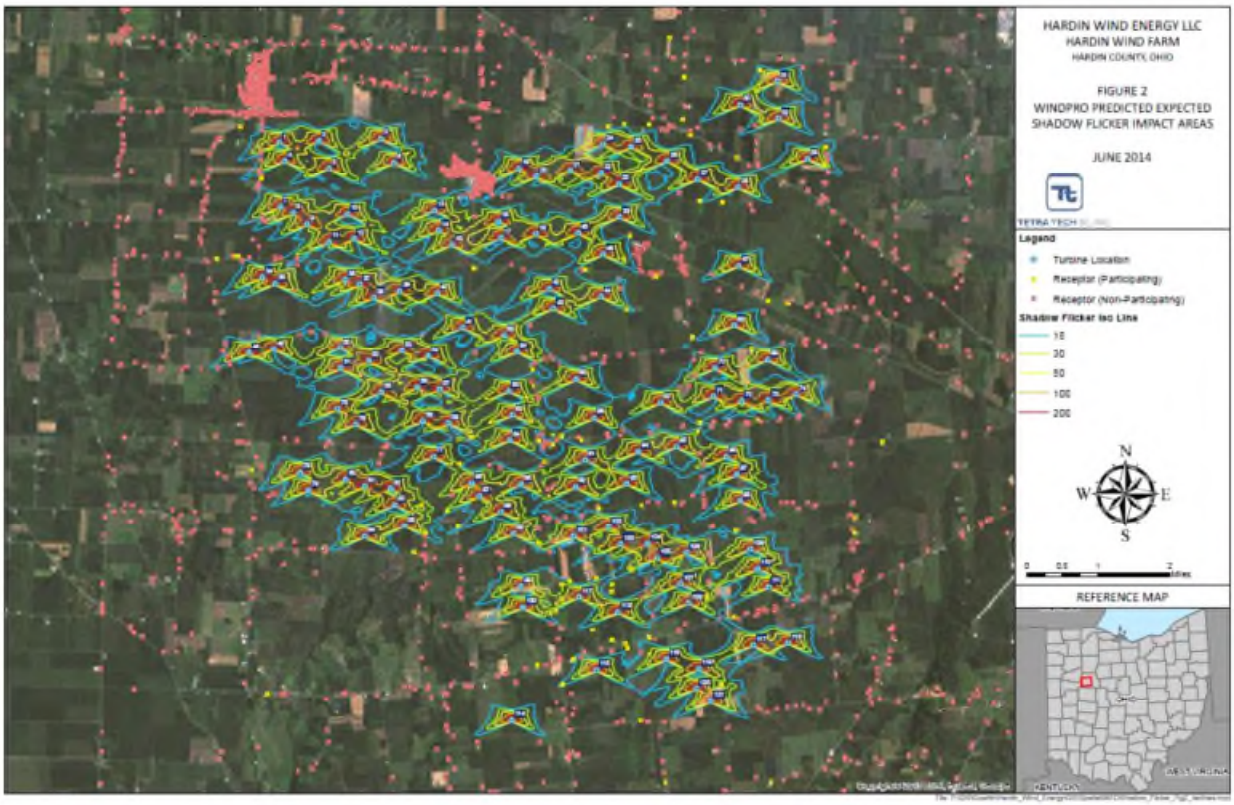


Figure 2 Map of Estimated Annual Average Shadow Hours for the Hardin Wind Farm



ATTACHMENT A

Detailed Summary of WindPro Shadow Flicker Analysis Results

Hardin Wind Farm
WindPro Expected Annual Average Shadows
Non-Participating Receptors

Receptor ID	Receptor Description	UTM-E (m)	UTM-N (m)	Expected Annual Average Shadow Hours (With cloud cover) (hrs/yr)
69491	H-4491	271,418	4,498,688	0:00
69493	H-4493	259,979	4,501,182	5:39
69536	H-4536	268,351	4,506,435	8:28
69559	H-4559	262,684	4,502,339	7:58
69607	H-4607	263,732	4,499,778	0:46
69621	H-4621	272,035	4,510,845	11:44
69623	H-4623	260,067	4,501,226	7:33
69640	H-4640	268,360	4,506,266	18:31
69665	H-4665	262,473	4,501,925	9:42
69666	H-4666	262,589	4,502,300	4:13
69696	H-4696	271,026	4,498,503	2:19
69697	H-4697	268,346	4,506,472	8:05
69708	H-4708	268,322	4,506,683	7:37
69709	H-4709	266,514	4,500,646	18:50
69716	H-4716	265,901	4,505,040	13:26
69721	H-4721	263,529	4,499,861	1:12
69725	H-4725	266,319	4,499,900	15:38
69736	H-4736	266,257	4,500,672	20:50
69738	H-4738	266,386	4,498,290	10:42
69742	H-4742	268,407	4,506,723	5:50
69743	H-4743	267,486	4,497,730	1:00
69744	H-4744	268,400	4,506,222	16:42
69745	H-4745	266,804	4,496,714	1:12
69747	H-4747	267,115	4,497,675	0:00
69749	H-4749	266,284	4,502,368	10:37
69753	H-4753	272,129	4,498,898	8:55
69754	H-4754	270,566	4,498,409	5:46
69755	H-4755	271,794	4,498,717	0:00
69762	H-4762	270,765	4,502,801	0:41
69764	H-4764	268,677	4,497,948	4:04
69771	H-4771	268,352	4,506,721	6:50
69772	H-4772	269,243	4,498,152	1:57
69779	H-4779	270,992	4,498,595	0:52
69784	H-4784	268,252	4,506,640	9:43
69786	H-4786	271,569	4,504,655	4:12
69790	H-4790	268,538	4,506,848	4:00
69793	H-4793	271,441	4,498,634	0:00
69795	H-4795	268,402	4,506,745	5:55
69825	H-4825	265,734	4,506,288	10:52
69827	H-4827	269,563	4,504,240	15:35
69830	H-4830	266,055	4,503,437	35:55:00
69844	H-4844	270,719	4,502,820	0:58
69848	H-4848	270,218	4,504,511	2:44
69859	H-4859	267,764	4,509,731	0:00
69864	H-4864	270,290	4,502,777	5:20
69866	H-4866	269,693	4,502,156	37:16:00
69867	H-4867	269,112	4,509,495	5:31
69871	H-4871	268,361	4,506,761	6:31
69881	H-4881	268,330	4,506,532	8:10
69893	H-4893	272,461	4,507,933	0:00

Receptor ID	Receptor Description	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
69918	H-4918	263,912	4,508,579	5:24
69921	H-4921	270,617	4,509,458	8:56
69945	H-4945	264,065	4,508,506	4:12
69956	H-4956	272,136	4,508,078	0:40
69958	H-4958	272,588	4,508,485	2:30
69962	H-4962	269,919	4,509,096	5:24
69965	H-4965	270,148	4,509,058	6:46
70009	H-5009	264,995	4,508,272	21:22
70061	H-5061	263,948	4,508,535	5:13
70104	H-5104	263,957	4,508,470	6:36
70106	H-5106	263,888	4,508,531	6:07
70107	H-5107	259,859	4,509,416	23:33
70112	H-5112	259,181	4,506,584	8:10
70117	H-5117	264,773	4,508,231	19:59
70119	H-5119	264,777	4,508,332	13:32
70121	H-5121	264,182	4,508,404	2:50
70122	H-5122	259,549	4,509,729	5:36
70125	H-5125	264,860	4,508,328	17:38
70128	H-5128	264,963	4,508,421	18:42
70132	H-5132	264,106	4,508,389	2:53
70133	H-5133	264,246	4,508,402	2:51
70136	H-5136	264,194	4,508,479	2:46
70140	H-5140	264,748	4,508,388	9:04
70142	H-5142	265,046	4,508,344	31:47:00
70143	H-5143	264,240	4,508,446	2:48
70144	H-5144	264,830	4,508,432	10:40
70146	H-5146	264,745	4,508,360	10:38
70148	H-5148	264,728	4,508,512	6:39
70149	H-5149	264,891	4,508,328	20:00
70151	H-5151	264,725	4,508,487	6:48
70152	H-5152	264,802	4,508,446	8:46
70154	H-5154	264,680	4,508,377	6:44
70157	H-5157	264,719	4,508,319	11:46
70175	H-5175	264,637	4,508,470	5:24
70186	H-5186	260,107	4,509,803	2:12
70192	H-5192	260,222	4,509,789	3:36
70193	H-5193	260,124	4,509,787	2:19
70203	H-5203	259,801	4,510,028	0:59
70204	H-5204	259,912	4,509,867	1:14
70209	H-5209	259,738	4,509,983	0:47
70214	H-5214	259,921	4,509,950	1:24
70218	H-5218	259,922	4,510,052	1:55
70220	H-5220	260,002	4,510,103	0:57
70240	H-5240	259,633	4,509,773	0:43
70250	H-5250	259,519	4,509,772	4:06
70255	H-5255	259,837	4,509,765	1:08
70256	H-5256	259,808	4,509,757	1:05
70257	H-5257	259,872	4,509,841	1:07
70259	H-5259	259,681	4,509,773	0:49
70260	H-5260	264,744	4,508,129	12:44
70261	H-5261	259,665	4,509,778	0:47
70264	H-5264	264,961	4,508,269	22:37
70268	H-5268	264,847	4,508,085	5:18
70274	H-5274	264,851	4,508,119	6:05
70277	H-5277	264,769	4,508,130	11:30

Receptor ID	Receptor Description	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
70278	H-5278	264,988	4,508,102	6:18
70279	H-5279	264,879	4,508,154	8:35
70286	H-5286	264,988	4,508,078	6:41
70352	H-5352	266,350	4,504,312	20:33
70354	H-5354	266,553	4,504,130	27:17:00
70365	H-5365	270,651	4,505,913	0:00
70366	H-5366	267,924	4,505,856	20:57
70371	H-5371	272,075	4,504,587	5:40
70718	H-5718	259,764	4,504,816	16:50
70962	H-5962	267,404	4,500,968	2:23
71004	H-6004	270,146	4,498,421	21:32
71012	H-6012	266,073	4,500,455	33:05:00
71020	H-6020	266,419	4,501,441	29:36:00
71027	H-6027	271,077	4,500,883	30:09:00
71061	H-6061	265,557	4,496,997	0:00
71068	H-6068	268,502	4,499,203	11:10
71081	H-6081	268,532	4,501,069	6:15
71082	H-6082	271,043	4,498,600	0:46
71113	H-6113	262,680	4,502,294	6:29
71136	H-6136	269,970	4,506,181	25:57:00
71155	H-6155	268,301	4,506,759	7:46
71159	H-6159	260,638	4,506,536	16:59
71160	H-6160	260,191	4,506,543	4:18
71161	H-6161	259,652	4,506,953	3:31
71164	H-6164	265,456	4,506,386	8:20
71169	H-6169	259,409	4,506,491	16:05
71174	H-6174	264,998	4,508,351	29:57:00
71175	H-6175	264,255	4,508,439	2:48
71176	H-6176	264,688	4,508,074	10:44
71178	H-6178	264,618	4,508,109	16:43
71180	H-6180	259,857	4,507,458	14:18
71181	H-6181	259,907	4,507,363	26:01:00
71182	H-6182	264,647	4,507,480	31:51:00
71184	H-6184	270,837	4,507,754	4:22
71185	H-6185	270,899	4,507,616	2:53
71199	H-6199	268,461	4,506,891	4:50
71205	H-6205	268,533	4,506,871	4:01
71206	H-6206	268,456	4,506,738	5:08
71208	H-6208	268,380	4,506,708	6:21
71209	H-6209	268,372	4,506,685	6:37
71211	H-6211	268,305	4,506,618	8:21
71212	H-6212	268,340	4,506,693	7:09
71214	H-6214	268,360	4,506,749	6:36
71215	H-6215	268,290	4,506,711	8:14
71217	H-6217	268,268	4,506,768	8:28
71220	H-6220	268,207	4,506,645	11:10
71221	H-6221	268,329	4,506,563	7:59
71223	H-6223	260,264	4,506,567	6:33
71224	H-6224	260,223	4,506,538	6:48
71226	H-6226	260,136	4,506,546	3:34
71227	H-6227	259,771	4,506,800	7:57
71229	H-6229	259,565	4,506,564	0:53
71247	H-6247	260,633	4,506,403	22:09
71248	H-6248	260,156	4,506,499	7:11
71253	H-6253	268,358	4,506,290	16:09

Receptor ID	Receptor Description	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
71255	H-6255	268,353	4,506,495	7:45
71302	H-6302	270,962	4,505,742	0:00
71304	H-6304	270,134	4,505,832	0:00
71307	H-6307	265,824	4,505,862	30:23:00
71308	H-6308	260,593	4,505,816	42:45:00
71319	H-6319	271,134	4,505,352	8:36
71328	H-6328	272,059	4,504,665	5:53
71331	H-6331	261,265	4,504,864	18:35
71332	H-6332	260,687	4,504,842	21:13
71334	H-6334	259,017	4,504,627	13:23
71344	H-6344	258,861	4,504,032	8:31
71345	H-6345	259,135	4,504,116	8:23
71346	H-6346	259,111	4,504,205	30:55:00
71347	H-6347	259,080	4,504,340	24:47:00
71348	H-6348	258,957	4,504,457	13:20
71349	H-6349	264,636	4,504,407	10:11
71350	H-6350	266,404	4,504,264	23:09
71354	H-6354	266,219	4,504,254	20:56
71356	H-6356	265,996	4,504,142	3:24
71358	H-6358	267,096	4,504,255	0:58
71361	H-6361	267,301	4,504,368	0:33
71362	H-6362	267,338	4,504,366	0:00
71363	H-6363	267,569	4,504,323	4:34
71364	H-6364	267,541	4,504,186	13:43
71368	H-6368	269,718	4,504,399	13:11
71376	H-6376	269,597	4,503,877	43:26:00
71377	H-6377	265,922	4,503,741	19:36
71383	H-6383	266,067	4,503,368	32:46:00
71384	H-6384	269,467	4,503,651	23:36
71387	H-6387	271,919	4,502,927	6:30
71388	H-6388	271,958	4,502,994	16:53
71389	H-6389	271,525	4,502,944	10:58
71390	H-6390	271,488	4,502,884	13:48
71391	H-6391	271,070	4,502,855	6:13
71393	H-6393	270,815	4,502,827	0:36
71394	H-6394	270,371	4,502,851	6:07
71396	H-6396	270,035	4,502,866	12:50
71397	H-6397	269,980	4,502,750	15:26
71399	H-6399	269,335	4,502,747	12:15
71400	H-6400	268,766	4,502,763	6:39
71401	H-6401	268,593	4,502,612	11:37
71403	H-6403	267,986	4,502,676	21:08
71404	H-6404	267,622	4,502,577	6:52
71405	H-6405	266,173	4,502,579	16:31
71412	H-6412	260,340	4,502,469	2:00
71413	H-6413	260,610	4,502,426	3:53
71414	H-6414	261,890	4,502,310	3:29
71415	H-6415	261,340	4,502,384	0:00
71416	H-6416	261,294	4,502,335	0:00
71417	H-6417	262,530	4,502,115	12:23
71421	H-6421	266,084	4,502,523	14:48
71424	H-6424	266,210	4,502,435	17:43
71426	H-6426	266,181	4,502,325	12:15
71427	H-6427	266,180	4,502,259	11:20
71431	H-6431	266,492	4,502,465	18:27

Receptor ID	Receptor Description	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
71433	H-6433	266,975	4,502,511	3:17
71435	H-6435	267,650	4,502,501	9:40
71436	H-6436	267,931	4,502,546	24:52:00
71441	H-6441	269,787	4,501,874	34:39:00
71442	H-6442	269,762	4,501,603	13:13
71444	H-6444	266,132	4,501,890	15:31
71446	H-6446	266,260	4,501,375	29:46:00
71447	H-6447	266,311	4,501,378	28:45:00
71448	H-6448	265,222	4,501,829	23:08
71449	H-6449	264,964	4,501,872	14:30
71452	H-6452	259,845	4,501,860	6:48
71459	H-6459	260,143	4,501,231	9:15
71462	H-6462	264,141	4,501,201	22:52
71464	H-6464	267,060	4,500,751	17:00
71466	H-6466	266,678	4,500,711	7:58
71467	H-6467	266,313	4,500,699	21:46
71470	H-6470	268,763	4,501,031	5:29
71475	H-6475	269,797	4,501,226	5:10
71476	H-6476	269,806	4,501,108	6:03
71477	H-6477	269,804	4,500,973	9:04
71479	H-6479	271,141	4,500,739	2:17
71481	H-6481	271,540	4,501,053	5:56
71486	H-6486	270,843	4,500,657	1:05
71487	H-6487	270,911	4,500,624	0:50
71489	H-6489	270,004	4,500,511	7:12
71491	H-6491	266,199	4,500,736	23:55
71494	H-6494	266,388	4,500,163	47:10:00
71496	H-6496	263,502	4,500,303	27:32:00
71497	H-6497	263,500	4,500,258	13:40
71527	H-6527	261,273	4,499,918	11:36
71528	H-6528	261,289	4,499,980	7:43
71530	H-6530	263,419	4,499,861	1:49
71531	H-6531	263,482	4,499,828	1:31
71534	H-6534	263,511	4,500,084	1:19
71535	H-6535	263,542	4,499,707	1:31
71540	H-6540	265,172	4,499,918	0:52
71541	H-6541	265,262	4,499,857	1:09
71543	H-6543	265,726	4,499,911	5:10
71545	H-6545	265,206	4,499,524	13:12
71546	H-6546	269,903	4,499,877	28:52:00
71547	H-6547	269,981	4,499,722	37:47:00
71560	H-6560	269,892	4,499,233	19:36
71561	H-6561	268,511	4,499,009	24:43:00
71563	H-6563	268,397	4,498,901	28:47:00
71572	H-6572	266,380	4,499,510	9:57
71576	H-6576	268,645	4,498,464	22:01
71578	H-6578	269,375	4,498,275	1:45
71584	H-6584	270,735	4,498,517	6:51
71587	H-6587	271,151	4,498,625	0:35
71589	H-6589	270,952	4,498,483	5:37
71590	H-6590	271,226	4,498,576	0:00
71591	H-6591	271,373	4,498,583	0:00
71594	H-6594	271,649	4,498,865	5:20
71595	H-6595	272,037	4,498,833	9:13
71606	H-6606	266,559	4,498,205	9:57

Receptor ID	Receptor Description	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
71615	H-6615	266,574	4,497,478	4:46
71616	H-6616	266,575	4,497,489	4:46
71617	H-6617	266,571	4,497,500	4:43
71618	H-6618	266,572	4,497,512	4:43
71619	H-6619	266,572	4,497,524	4:44
71620	H-6620	266,539	4,497,520	4:19
71621	H-6621	266,540	4,497,506	4:18
71622	H-6622	266,540	4,497,495	4:18
71623	H-6623	266,540	4,497,484	4:20
71624	H-6624	266,543	4,497,470	4:26
71627	H-6627	267,018	4,497,545	21:01
71630	H-6630	267,736	4,497,695	1:50
71633	H-6633	268,369	4,497,676	14:17
71667	H-6667	270,321	4,495,969	0:00
71670	H-6670	266,112	4,495,635	0:00
71671	H-6671	264,692	4,495,625	0:00
76919	H-6919	259,925	4,510,091	1:46
76925	H-6925	259,973	4,510,102	1:23
76934	H-6934	259,868	4,509,625	1:22
76935	H-6935	259,866	4,509,672	1:20
76936	H-6936	259,871	4,509,717	1:19
76937	H-6937	259,867	4,509,748	1:17
76938	H-6938	259,875	4,509,771	1:15
76939	H-6939	259,764	4,509,769	0:59
76940	H-6940	259,745	4,509,768	0:57
76941	H-6941	259,698	4,509,775	0:51
76942	H-6942	259,862	4,509,558	8:40
76943	H-6943	259,865	4,509,587	5:12
76944	H-6944	259,873	4,509,801	1:10
76945	H-6945	259,875	4,509,817	1:08
76946	H-6946	259,908	4,509,796	1:16
76947	H-6947	259,928	4,509,796	1:20
76948	H-6948	259,958	4,509,794	1:25
76949	H-6949	259,959	4,509,806	1:26
76950	H-6950	259,961	4,509,817	1:27
76951	H-6951	259,961	4,509,829	1:27
76952	H-6952	259,961	4,509,841	1:27
76953	H-6953	259,961	4,509,852	1:26
76954	H-6954	259,961	4,509,863	1:27
76955	H-6955	259,962	4,509,874	1:27
76956	H-6956	259,963	4,509,898	1:29
76957	H-6957	259,999	4,509,898	1:44
76958	H-6958	260,000	4,509,886	1:42
76959	H-6959	259,999	4,509,875	1:38
76960	H-6960	259,997	4,509,864	1:37
76961	H-6961	259,999	4,509,852	1:36
76962	H-6962	259,998	4,509,841	1:35
76963	H-6963	259,998	4,509,829	1:36
76964	H-6964	259,999	4,509,816	1:36
76965	H-6965	259,998	4,509,806	1:36
76966	H-6966	260,036	4,509,791	1:46
76967	H-6967	260,037	4,509,803	1:45
76968	H-6968	260,040	4,509,814	1:48
76969	H-6969	260,038	4,509,826	1:48
76970	H-6970	260,039	4,509,838	1:50

Receptor ID	Receptor Description	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
76971	H-6971	260,039	4,509,850	1:51
76972	H-6972	260,040	4,509,860	1:53
76973	H-6973	260,040	4,509,872	1:55
76974	H-6974	260,042	4,509,884	1:58
76975	H-6975	260,044	4,509,896	2:04
76976	H-6976	260,082	4,509,892	2:32
76977	H-6977	260,081	4,509,879	2:23
76978	H-6978	260,080	4,509,867	2:16
76979	H-6979	260,079	4,509,856	2:11
76980	H-6980	260,079	4,509,844	2:07
76981	H-6981	260,081	4,509,832	2:07
76982	H-6982	260,169	4,509,789	2:43
76983	H-6983	260,287	4,509,785	4:48
76984	H-6984	260,402	4,509,793	4:26
76985	H-6985	260,501	4,509,813	0:11
76986	H-6986	260,441	4,509,815	2:09
76987	H-6987	259,817	4,509,803	1:02
76988	H-6988	259,917	4,509,887	1:16
76989	H-6989	259,640	4,509,816	0:44
76990	H-6990	259,733	4,509,811	0:52
76991	H-6991	259,735	4,509,853	0:49
76992	H-6992	259,734	4,509,871	0:47
76993	H-6993	259,673	4,509,888	0:40
76994	H-6994	259,626	4,509,853	0:40
76997	H-6997	259,576	4,509,771	2:26
76998	H-6998	259,469	4,509,716	5:35
76999	H-6999	259,528	4,509,783	3:16
77000	H-7000	259,545	4,509,815	1:01
77024	H-7024	259,841	4,508,905	15:18
77025	H-7025	259,838	4,508,757	19:12
77026	H-7026	259,811	4,508,489	21:33
77027	H-7027	259,812	4,508,543	34:39:00
77028	H-7028	259,770	4,508,215	7:13
77029	H-7029	259,821	4,508,368	1:05
77031	H-7031	259,740	4,508,112	13:44
77032	H-7032	260,574	4,509,788	0:00
77033	H-7033	260,603	4,509,787	0:00
77049	H-7049	267,111	4,509,496	13:56
77053	H-7053	268,838	4,509,449	10:13
77055	H-7055	268,657	4,509,701	1:58
77056	H-7056	268,884	4,509,727	0:56
77057	H-7057	268,990	4,509,542	7:47
77058	H-7058	268,977	4,509,442	7:03
77059	H-7059	269,483	4,509,425	5:32
77063	H-7063	263,991	4,508,441	6:18
77064	H-7064	263,995	4,508,523	4:43
77065	H-7065	264,062	4,508,407	2:58
77066	H-7066	264,188	4,508,438	2:48
77067	H-7067	264,227	4,508,480	2:46
77075	H-7075	264,152	4,508,493	2:46
77076	H-7076	264,147	4,508,440	2:49
77095	H-7095	264,673	4,508,418	6:13
77096	H-7096	264,680	4,508,455	6:08
77097	H-7097	264,673	4,508,478	5:54
77098	H-7098	264,678	4,508,499	5:55

Receptor ID	Receptor Description	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
77099	H-7099	264,681	4,508,535	5:44
77100	H-7100	264,754	4,508,495	7:17
77102	H-7102	264,828	4,508,446	9:48
77103	H-7103	264,829	4,508,423	11:12
77104	H-7104	264,827	4,508,412	11:45
77105	H-7105	264,880	4,508,449	12:35
77106	H-7106	264,862	4,508,410	13:46
77107	H-7107	264,860	4,508,384	14:48
77108	H-7108	264,858	4,508,371	15:17
77109	H-7109	264,889	4,508,385	16:11
77110	H-7110	264,893	4,508,371	17:05
77111	H-7111	264,916	4,508,385	17:40
77112	H-7112	264,953	4,508,357	23:05
77113	H-7113	264,908	4,508,444	14:25
77114	H-7114	264,910	4,508,431	15:07
77115	H-7115	264,890	4,508,353	17:55
77116	H-7116	264,720	4,508,385	7:52
77117	H-7117	264,780	4,508,386	10:49
77118	H-7118	264,635	4,508,501	5:12
77126	H-7126	264,645	4,508,646	4:36
77150	H-7150	264,697	4,508,672	5:01
77151	H-7151	264,701	4,508,634	5:21
77152	H-7152	265,069	4,508,290	20:22
77153	H-7153	264,998	4,508,320	28:40:00
77154	H-7154	264,995	4,508,291	24:57:00
77155	H-7155	264,995	4,508,244	15:45
77156	H-7156	264,987	4,508,195	7:06
77157	H-7157	265,024	4,508,193	5:47
77158	H-7158	264,955	4,508,197	9:52
77159	H-7159	264,913	4,508,205	13:59
77160	H-7160	264,889	4,508,198	14:19
77161	H-7161	264,887	4,508,181	11:54
77162	H-7162	264,852	4,508,201	16:41
77163	H-7163	264,817	4,508,195	17:32
77164	H-7164	264,768	4,508,203	19:12
77165	H-7165	264,731	4,508,203	18:58
77166	H-7166	264,666	4,508,201	15:34
77167	H-7167	264,661	4,508,181	17:26
77170	H-7170	264,671	4,508,307	10:19
77171	H-7171	264,723	4,508,335	11:05
77172	H-7172	264,855	4,508,278	22:30
77173	H-7173	264,852	4,508,251	21:55
77174	H-7174	264,779	4,508,247	19:46
77175	H-7175	264,777	4,508,268	16:48
77176	H-7176	264,783	4,508,359	12:33
77177	H-7177	264,674	4,508,363	6:53
77178	H-7178	264,887	4,508,295	23:51
77179	H-7179	264,886	4,508,278	23:37
77180	H-7180	264,885	4,508,252	22:02
77181	H-7181	264,936	4,508,323	26:12:00
77182	H-7182	264,967	4,508,299	26:25:00
77183	H-7183	264,966	4,508,322	27:54:00
77184	H-7184	264,993	4,508,150	5:51
77185	H-7185	264,991	4,508,124	6:05
77186	H-7186	264,960	4,508,152	5:31

Receptor ID	Receptor Description	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
77187	H-7187	264,946	4,508,086	6:03
77188	H-7188	264,953	4,508,119	5:45
77189	H-7189	265,021	4,507,956	14:26
77190	H-7190	265,262	4,507,948	3:43
77191	H-7191	264,879	4,508,105	5:18
77192	H-7192	264,667	4,508,133	16:59
77193	H-7193	264,665	4,508,114	15:21
77194	H-7194	264,668	4,508,041	8:54
77195	H-7195	264,663	4,508,024	7:52
77196	H-7196	264,652	4,507,971	7:00
77197	H-7197	264,607	4,508,065	13:05
77198	H-7198	264,612	4,508,135	17:07
77199	H-7199	264,665	4,508,163	18:14
77200	H-7200	264,770	4,508,162	15:14
77201	H-7201	264,821	4,508,164	13:05
77202	H-7202	264,837	4,508,160	11:43
77203	H-7203	264,850	4,508,159	11:00
77204	H-7204	264,846	4,508,185	14:42
77205	H-7205	264,707	4,507,962	7:07
77206	H-7206	264,723	4,507,958	7:17
77207	H-7207	264,671	4,507,974	6:59
77208	H-7208	264,749	4,508,979	3:33
77209	H-7209	264,714	4,508,713	4:45
77210	H-7210	269,249	4,508,025	4:32
77212	H-7212	271,035	4,508,609	6:02
77213	H-7213	270,986	4,508,693	4:14
77214	H-7214	270,971	4,508,960	3:19
77215	H-7215	270,970	4,509,188	3:20
77217	H-7217	270,822	4,508,648	4:08
77218	H-7218	272,549	4,508,246	0:00
77219	H-7219	272,494	4,508,253	0:00
77220	H-7220	272,023	4,508,265	0:54
77224	H-7224	272,538	4,509,507	3:24
77228	H-7228	270,936	4,509,539	32:22:00
77231	H-7231	272,536	4,507,882	0:00
77279	H-7279	259,922	4,509,987	1:31
77280	H-7280	259,919	4,510,029	1:50
77281	H-7281	259,882	4,509,973	1:15
77282	H-7282	259,879	4,509,994	1:15
77283	H-7283	259,887	4,510,024	1:27
77284	H-7284	259,883	4,510,059	1:41
77301	H-7301	267,052	4,506,298	8:12
77302	H-7302	265,437	4,507,940	4:06
77303	H-7303	264,503	4,507,987	12:59
77304	H-7304	264,559	4,507,917	12:28
77305	H-7305	264,760	4,508,097	9:02
82541		266,256	4,501,347	31:04:00
82567		260,633	4,502,438	3:36
82568		260,653	4,502,442	3:19
82569		260,655	4,502,413	4:06
82570		260,959	4,504,874	13:14
82580		272,577	4,508,873	19:49
82581		272,603	4,508,748	20:32
82593		271,813	4,510,998	0:00
82596		271,487	4,511,014	0:00

Receptor ID	Receptor Description	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
82604		270,663	4,511,005	4:27
82606		263,939	4,508,069	5:36

Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary
Participating Receptors

Receptor ID	Receptor Description	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
69678	H-4678	267,718	4,497,944	1:32
69703	H-4703	270,525	4,500,404	3:59
69712	H-4712	267,733	4,499,021	7:44
69715	H-4715	268,083	4,497,745	12:24
69723	H-4723	268,197	4,499,520	26:37:00
69729	H-4729	266,578	4,502,539	13:35
69730	H-4730	266,787	4,499,261	10:55
69733	H-4733	266,608	4,496,937	17:47
69750	H-4750	268,015	4,497,850	3:15
69796	H-4796	267,427	4,500,909	3:00
69798	H-4798	265,943	4,504,023	5:57
69812	H-4812	269,865	4,498,845	32:38:00
69838	H-4838	270,997	4,502,900	7:21
69847	H-4847	270,182	4,496,933	15:51
69922	H-4922	269,319	4,509,660	4:13
69924	H-4924	271,053	4,510,774	19:05
69943	H-4943	268,566	4,509,562	2:29
69949	H-4949	270,530	4,508,792	6:06
69963	H-4963	272,509	4,508,647	43:04:00
69968	H-4968	272,537	4,509,052	26:54:00
70341	H-5341	265,953	4,503,628	19:27
70361	H-5361	263,497	4,500,338	35:48:00
70367	H-5367	269,538	4,504,786	6:07
70960	H-5960	266,078	4,502,424	17:25
70995	H-5995	266,353	4,498,527	12:50
71001	H-6001	266,583	4,499,167	30:29:00
71131	H-6131	266,069	4,500,091	33:26:00
71152	H-6152	267,997	4,506,542	28:50:00
71171	H-6171	269,694	4,507,821	13:03
71218	H-6218	268,136	4,507,050	13:37
71230	H-6230	259,320	4,506,583	13:45
71231	H-6231	259,268	4,506,589	10:12
71301	H-6301	271,238	4,505,591	6:10
71317	H-6317	268,059	4,505,389	18:00
71371	H-6371	270,856	4,504,495	28:17:00
71398	H-6398	269,701	4,502,830	17:19
71419	H-6419	264,571	4,502,499	20:52
71420	H-6420	264,288	4,501,901	25:42:00
71428	H-6428	266,399	4,502,335	9:42
71429	H-6429	266,214	4,501,971	15:28
71434	H-6434	267,036	4,502,461	3:14
71460	H-6460	263,421	4,500,995	36:49:00
71461	H-6461	264,032	4,500,846	20:58
71469	H-6469	268,393	4,500,991	9:24
71495	H-6495	264,264	4,500,495	13:05
71529	H-6529	263,258	4,499,914	2:59
71564	H-6564	267,722	4,499,179	7:37
71566	H-6566	267,375	4,499,307	7:50
71569	H-6569	268,153	4,499,498	23:19
71570	H-6570	266,580	4,498,843	50:54:00

Receptor ID	Receptor Description	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
71575	H-6575	266,456	4,498,573	9:16
71581	H-6581	269,860	4,498,897	42:07:00
71582	H-6582	270,452	4,498,458	6:03
71602	H-6602	268,563	4,497,983	4:22
71605	H-6605	267,294	4,498,164	0:40
71626	H-6626	266,866	4,497,499	11:48
71634	H-6634	268,560	4,497,627	27:09:00
76933	H-6933	264,614	4,506,311	6:29
77009	H-7009	259,380	4,509,500	6:31
77030	H-7030	259,828	4,508,334	1:10
77050	H-7050	267,636	4,509,515	8:18
77051	H-7051	267,992	4,509,552	5:40
77061	H-7061	269,481	4,509,314	1:19
77211	H-7211	270,222	4,507,803	0:00
77227	H-7227	270,963	4,510,327	43:07:00
77300	H-7300	267,133	4,506,298	5:21
77306	H-7306	269,660	4,502,650	23:09

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Case No(s). 14-1030-EL-BGA

Summary: Correspondence of Hardin Wind Energy LLC Submitting Shadow Flicker Study electronically filed by Teresa Orahood on behalf of Sally Bloomfield